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## METHOD AND DEVICE FOR MEASURING AN ELECTRICAL VOLTAGE

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### Background of the Invention

The invention concerns a method and a device for optical measurement of an electrical voltage, preferably a high voltage.

Conventional voltage transformers used for measuring high voltages in power technology installations are based on an inductive measurement principle; capacitive voltage dividers may also be used in addition. In conventional transformers, expenditure on insulation increases at a disproportionately high rate in relation to the transmission voltage of the power supply network (see A.J. Schwab, "Hochspannungsmeßtechnik [High-Voltage Measuring Techniques]"). Electromagnetic compatibility (EMC) has gained in importance in the course of increasing digitalization of the measuring technology following the transformers, wherein this measuring technology generally has lower interference thresholds than conventional analog measurement technology. Because of the inductive-capacitive coupling of the primary plan (supply side) to the secondary plane (measurement and control side) in conventional voltage transformers, their use in connection with digital network technology turns out to be problematic as concerns EMC (see H. Hirsch, "Polarimetrische faseroptische Stromwandler [Polarimetric fiber-optic current transformers]"). Compared to conventional transformers, little raw material is used owing to the small size of optical component assemblies. Optical transformers do not require any oil for insulation in principle, so that the risk of contamination of adjoining soil with oil in the event of a transformer explosion due to defects on the network side or device side is nonexistent.

Optical measuring methods in which electrical fields and electrical voltages are measured via the Pockels effect in electro-optical crystals are already generally known from different references. In this connection, the physical properties of an electro-optical medium change as a function of the electrical field strength in such a way that the polarization state of the optical wave propagating through the sensor medium is influenced by a linear birefringence induced by the electrical field. With the help of an optical arrangement comprising a polarizer, a delay element, an electro-optical material and an analyzer, in combination with electronic evaluating means, the measurement signal can be acquired for determining the electric.

coupled into a light waveguide. In a suggested arrangement, the light waveguide is guided along a curvy path in order to increase the effect. A high temperature dependency of the measurement signal caused by the linear birefringence of the light waveguide induced by bending would be expected in this embodiment.

DE-EB 1591976 describes an electro-optical voltage reducing device and its application for measuring voltages. In this case, the polarization of a light bundle traversing a quantity of electro-optical cells which are electrically connected in series is changed and read out by a Pockels cell via a compensating circuit. In principle, the described arrangement is a resistive-capacitive splitter whose voltage drops across partial capacitances are read optically. The method has the disadvantage that temperature dependencies of the optical elements are not compensated and that the suggested device is uneconomical in technical respects and is accordingly expensive to produce because the cost of the voltage divider is added to that of the optical construction. Further, the compensation circuit necessitates supply of a secondary electrical voltage.

DE 4436181 A1 discloses a method and a device for measuring an electrical AC quantity with temperature compensation through fitting. A suggested scaling circuit takes the ratio of AC signal component to DC signal component of the intensity signal of the optical wave detected by the receivers. A divider is used to carry out this function. No steps are indicated for suppressing the effects of tolerances of the structural component parts in the scaling stage.

### Summary of the Invention

Therefore, it is the object of the invention to provide a method and a device for measuring an electrical AC voltage by means of the electro-optical effect in which the measurement can be carried out under open-air condition also in the high-voltage and very high-voltage planes in a technically simple manner. The method and the device will contain steps for reducing the effects of temperature changes on optical and electrical parameters of the device. A modular, scalable construction is aimed for in order to reduce cost and increase production piece numbers.

This object is met in that a method and a device for measuring an electrical AC voltage are proposed which make use of at least one sensor element and evaluating

means by utilizing the Pockels effect and using at least one light source and at least one optical transmission path. The sensor element contains at least



### Brief Description of the Drawings

The invention will be described more fully in the following in an embodiment example. Shown in the accompanying drawings are:

- Fig. 1 the principle of a Pockels cell based on the transverse electro-optical effect;
- Fig. 2 principle of a Pockels cell based on the longitudinal electro-optical effect;
- Fig. 3 principle of an expanded Pockels cell for voltage measurement and temperature detection;
- Fig. 4 use of a plurality of sensor crystals for voltage measurement;
- Fig. 5 basic construction of the device for measuring a voltage;
- Fig. 6 basic modular construction of the device for adapting the voltage plane;
- Fig. 7 basic construction of the evaluating means;
- Fig. 8 conventional scaling of an optical signal by means of dividers;
- Fig. 9 scaling of the optical signal by means of regulated multiplier

### Description of the Preferred Embodiments

As is known, the measurement of the electrical field can be carried out with a Pockels cell. Figs. 1 and 2 show the basic construction of a Pockels cell. A light source 31 emits an optical wave which is guided via a polarizer 11, an electro-optical element 12, a delay element 13 and an analyzer 14, to an optoelectronic transducer 32. When a crystal without natural linear birefringence is used as electro-optical element 12, the operating point of the arrangement should be set at a delay of a quarter wavelength to ensure maximum sensitivity and linearity through the use of a

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